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(54) Dispensing molten metal for casting

(57) Casting apparatus comprises a tank 2 defining a tank chamber 3 receiving molten metal 4 in use, a housing 12 defining a bore 16, a piston 18 slidably received in the bore to define in the bore a dispensing chamber of variable volume, valve means 25 selectively operable in a first position to connect the dispensing chamber to the tank chamber and in a second position to connect the dispensing chamber to a discharge nozzle 36, the housing being connected to the tank such that in use the housing projects downwardly from and externally of the tank and such that the bore has an upper end communicating with the lowermost portion of the tank chamber, and further comprising heating means 7, 44, (52, Fig. 2, not shown) operable to heat the housing. The apparatus avoids the need for immersing the housing in molten metal to achieve uniform heating.

FIG. 1.

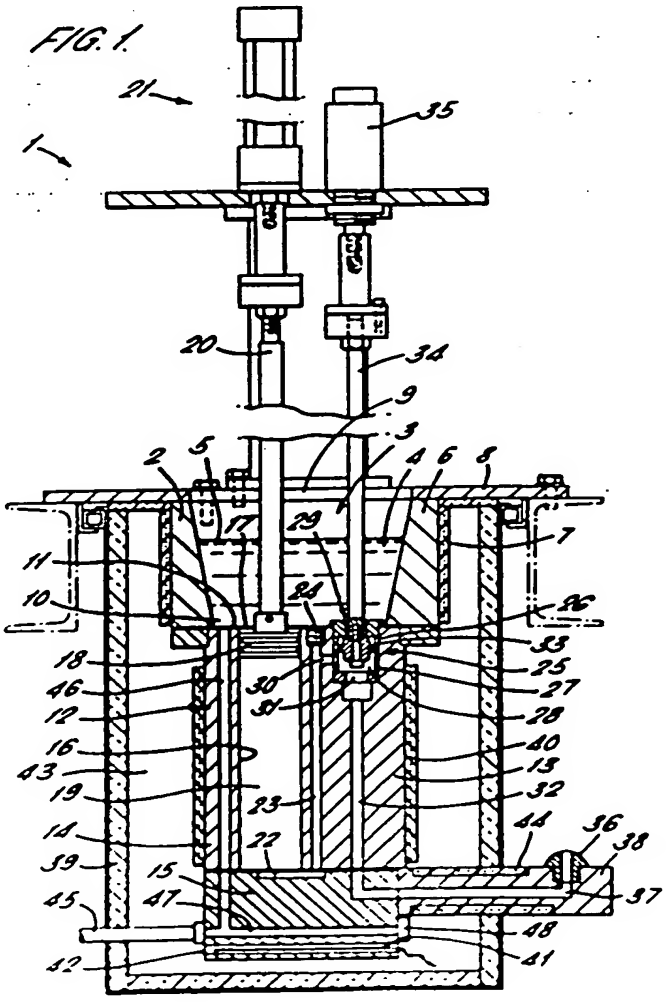

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FIG. 1.

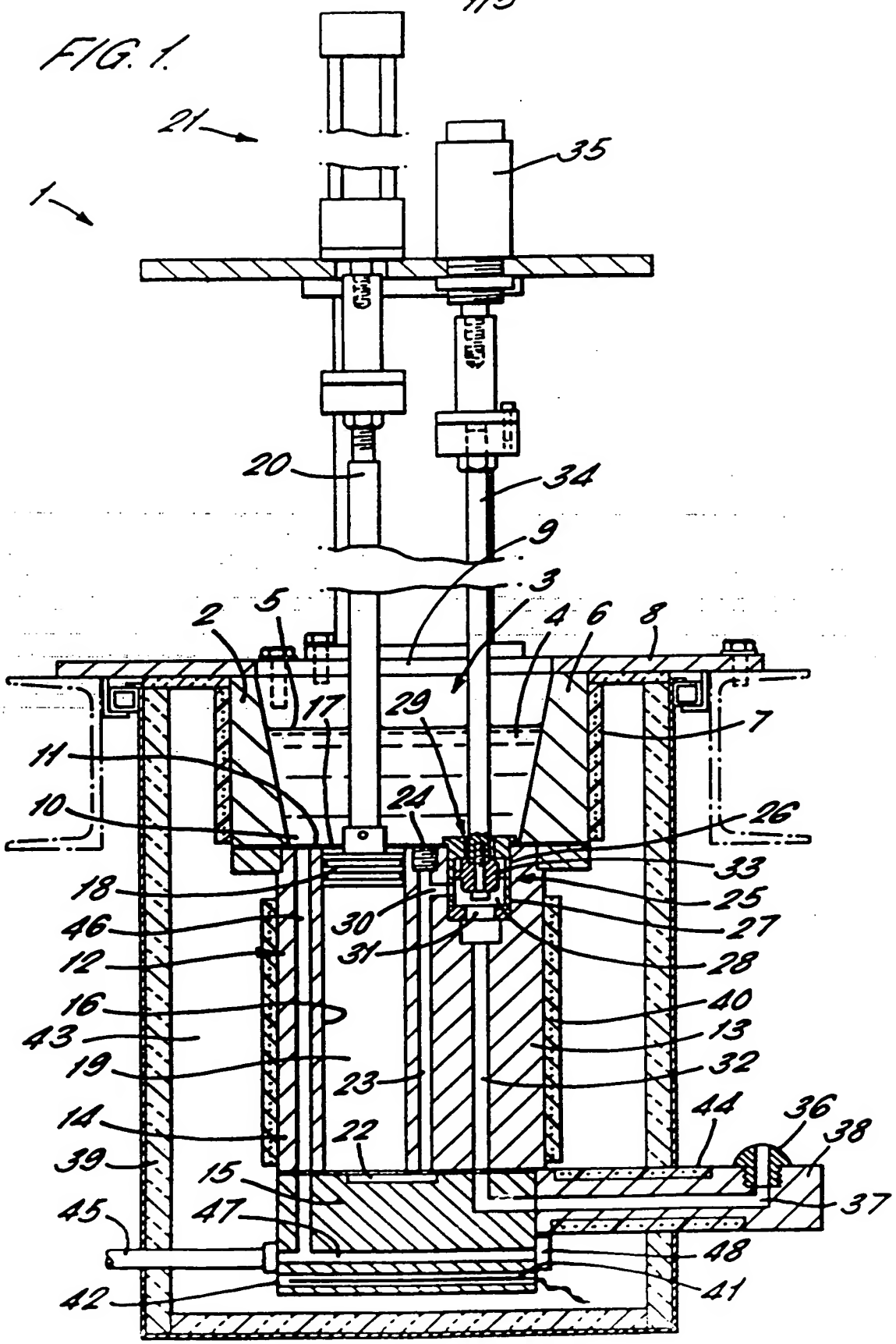
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FIG. 2.

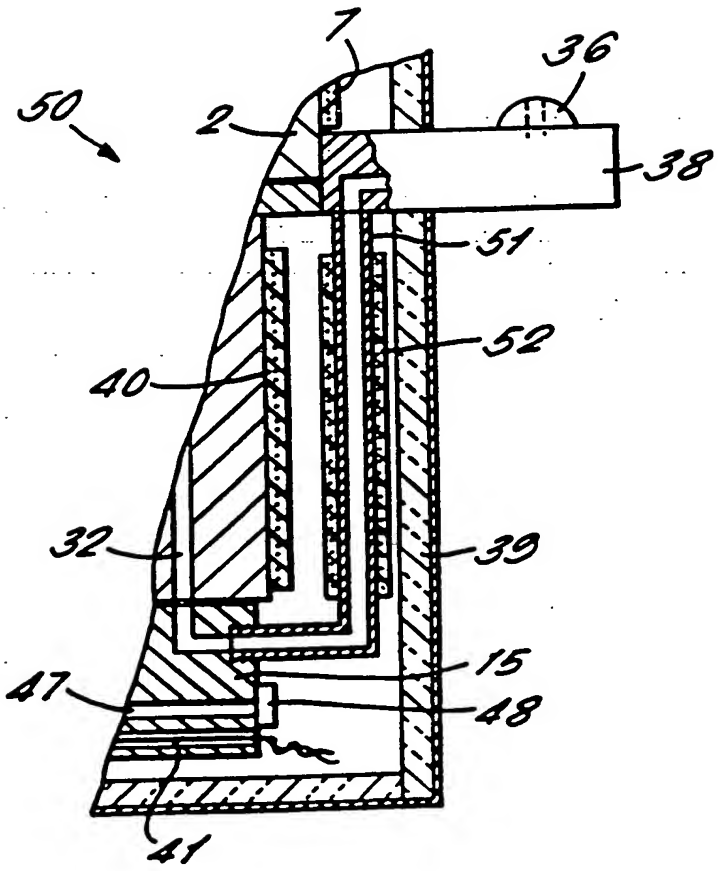

FIG. 3.

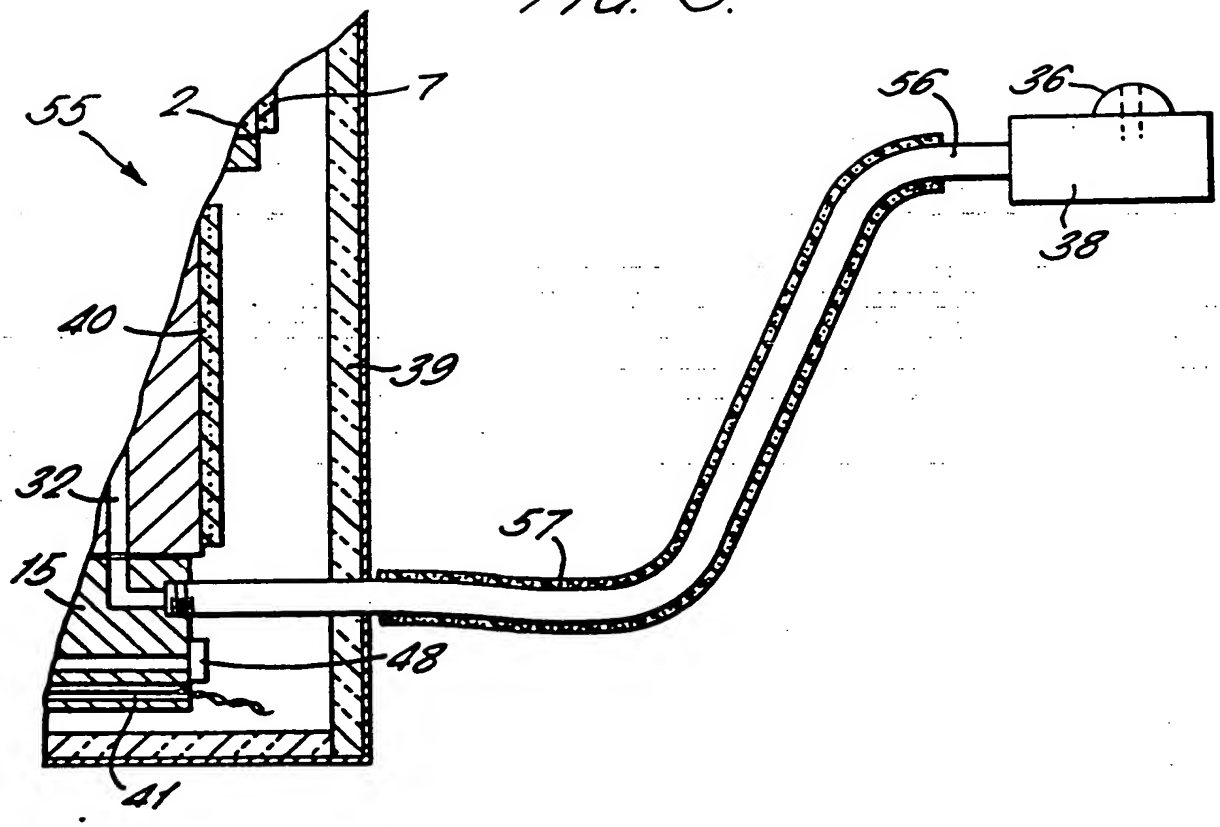

FIG. 4.

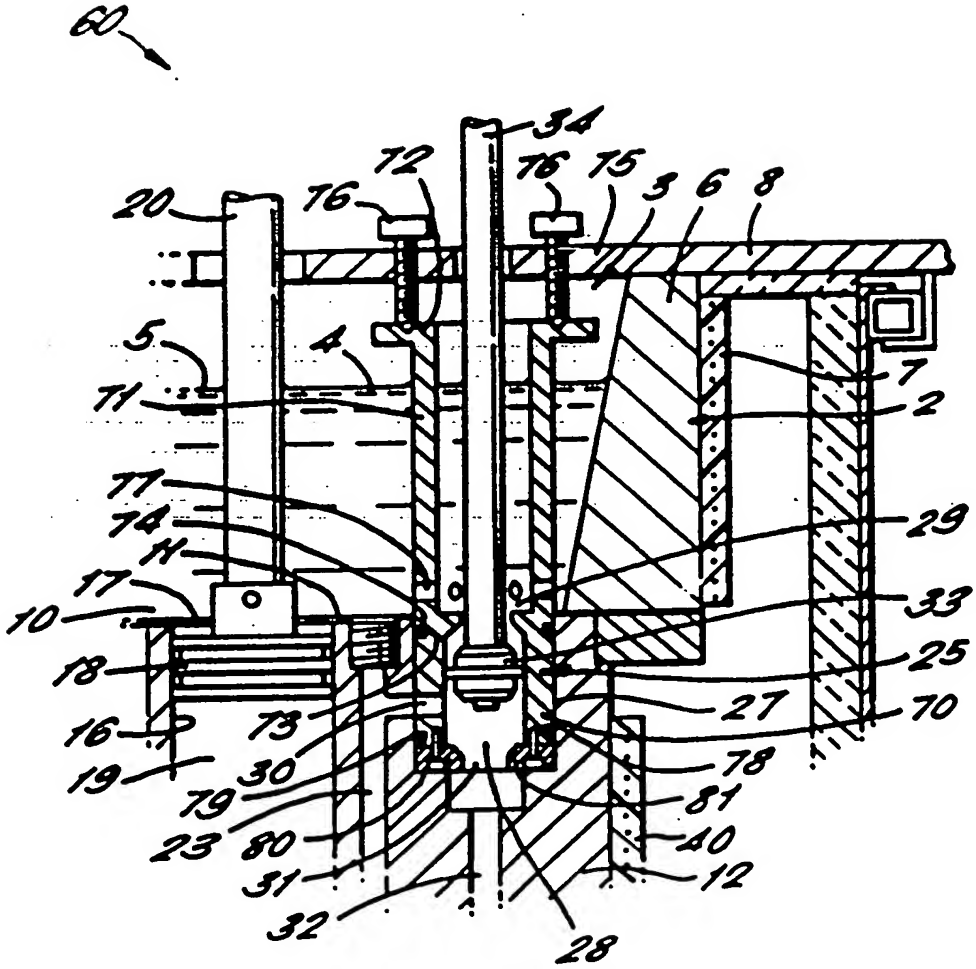
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FIG. 5.

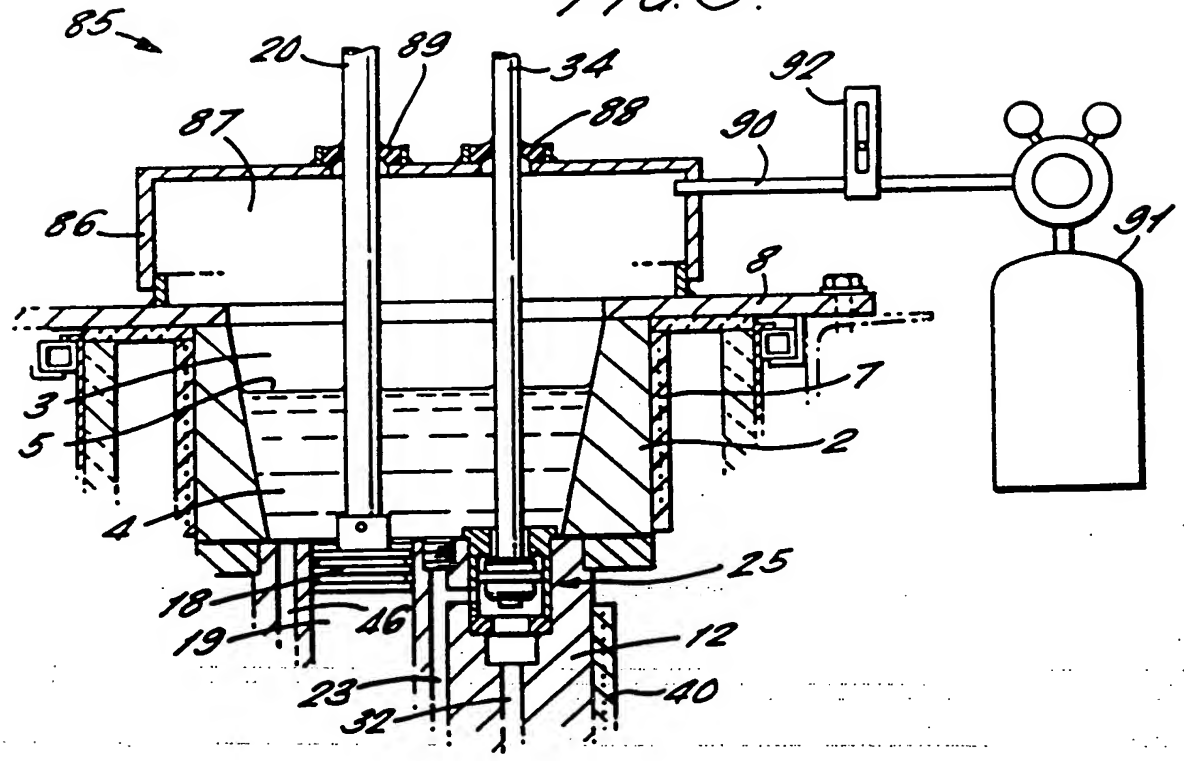
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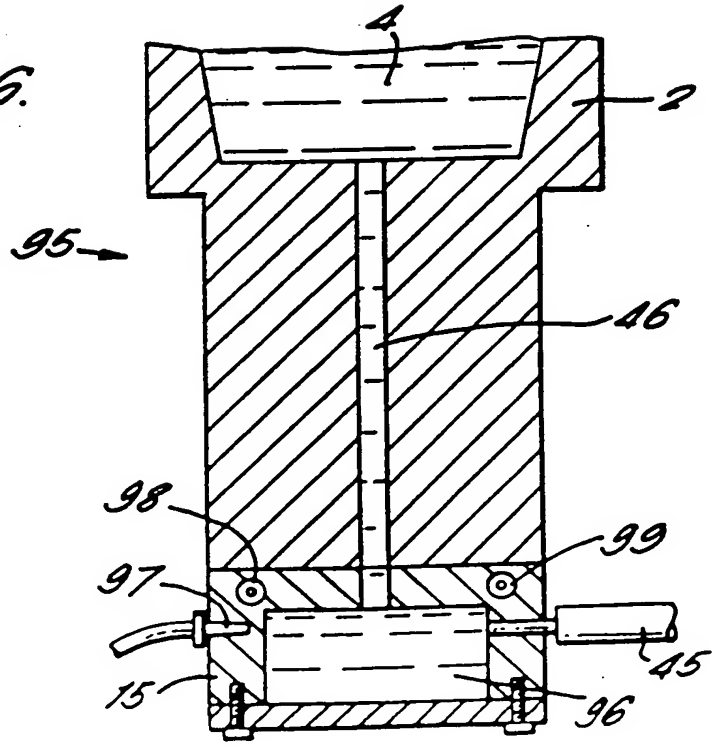
FIG. 6.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"CASTING APPARATUS"

This invention relates to casting apparatus for molten metal and in particular but not exclusively to casting apparatus for low melting point alloys for use in moulding plastics materials and in workpiece encapsulation.

It is known from GB-2232369A to provide casting apparatus in which molten metal is dispensed from a dispensing chamber within a housing by means of a piston, the housing being immersed in molten metal within a tank chamber which holds a reserve of molten metal. A valve means for connecting the dispensing chamber to a discharge nozzle is also immersed within the tank chamber. The housing and valve means are thereby maintained at the temperature of the molten metal in which they are immersed in order to ensure an even temperature throughout the apparatus to reduce the likelihood of local solidification of metal (or variations in composition where the metal is an alloy) and to aid the production of consistently high quality castings.

According to the present invention there is disclosed casting apparatus comprising a tank defining a tank chamber receiving molten metal in use, a housing defining a bore, a piston slidably received in the bore to define in the bore a dispensing chamber of variable volume, valve means selectively operable in a first position to connect the dispensing chamber to the tank chamber and in a second position to connect the dispensing chamber to a discharge nozzle, the housing being connected to the tank such that in use the housing projects downwardly from and externally of the tank and such that the bore has an upper end communicating with the lowermost portion of the tank chamber, and further

comprising heating means operable to heat the housing.

An advantage of such casting apparatus is that the housing is not immersed in use in molten metal and is thereby more accessible for maintenance. A smaller volume of molten metal is required for successful operation of the casting apparatus since it was previously necessary to maintain a volume of molten metal to a level sufficient to provide heating of the housing.

Preferably the valve means comprises a valve body formed integrally with the housing such that the valve means is heated in use by action of the heating means.

It is thereby no longer necessary for the valve means to be immersed in molten metal for the apparatus including the valve means to be heated to an even temperature to ensure satisfactory operation.

Preferably the valve body defines a valve chamber having an inlet port communicating with the lowermost portion of the tank chamber.

It is thereby possible to entirely consume the molten metal within the tank chamber since at each stroke of the dispensing piston the dispensing chamber is filled via the inlet port.

Preferably the heating means comprises an electrically heated jacket operable to heat an external surface of the housing.

Conveniently the heating means comprises an electrically heated cartridge located in a channel defined by a lower portion of the housing.

Advantageously the tank chamber has a bottom surface constituted by a top surface of the housing.

Th overall construction of the apparatus is thereby simplified and direct contact betw en the molten metal in the tank chamber and the housing contributes to the maintenance of an even temperature

distribution throughout the apparatus by thermal conduction between the molten metal and the top surface of the housing.

The valve body may be removably connected to the housing and include an extension which projects in use from the body through the tank chamber to a level which is above the level of molten metal so as to be accessible for removal of the valve body from the housing.

The valve body may thereby be removed without draining alloy from the tank.

Conveniently the valve body is slidably received in a recess defined in the housing, the valve means comprising seal means disposed between the body and the housing.

The tank may conveniently be provided with a hood defining an enclosure covering the tank chamber and means operable to introduce inert gas such as nitrogen into the enclosure.

Specific embodiments of the present invention will now be described by way of example only and with reference to the accompanying drawings of which:-

Figure 1 is a sectional elevation of casting apparatus having a discharge nozzle connected to a lower portion of the housing;

Figure 2 is a sectional elevation of part of an alternative apparatus having a discharge nozzle connected to an upper portion of the housing;

Figure 3 is a sectional elevation of a further alternative apparatus having a discharge nozzle connected by a flexible hose to a lower portion of the housing; and

Figur 4 is a further alternative apparatus having a modified valve,

Figure 5 is a sectional elevation of a further alternative apparatus including a sealed hood

pressurised with inert gas, and

Figure 6 is a sectional elevation of a further alternative apparatus including a pre-heating chamber for alloy returned to the tank after use.

In Figure 1 a casting apparatus 1 has a tank 2 defining a tank chamber 3 containing molten alloy 4 to a level 5. The alloy 4 is a low temperature alloy having a solidus temperature in the range 35°C to 300°C.

The tank 2 comprises a cylindrical wall 6 which is externally contacted by a cylindrical electrical band heater 7.

The tank 2 depends from a horizontal support plate 8 defining an aperture 9 which provides access from above to the tank chamber 3.

The tank chamber 3 has a lowermost portion 10 which is closed by an upper surface 11 of a housing 12 which is connected to the tank so as to project downwardly from the tank.

The housing 12 consists of a cylindrical cast iron block 13 having a lower end portion 14 to which is connected a cast iron base 15. A cylindrical bore 16 extends vertically through the block 13 and has an upper end 17 communicating with the lowermost portion 10 of the tank chamber 3. A piston 18 is slidably received in the bore to vary the volume of a dispensing chamber 19 formed within the bore beneath the piston. A piston rod 20 connects the piston 18 to a piston actuator 21 arranged to reciprocate the piston in a controlled manner. The piston rod 20 passes through the upper end 17 of the bore 16 and projects upwardly from the alloy 4 so as to extend through the ap rtur 9.

The dispensing chamber 19 is closed at its lower end portion 14 by the base 15 in which is formed a channel 22 communicating between the

dispensing chamber and a transfer duct 23 extending vertically through the block 13.

The transfer duct 23 is closed at its upper end by a threaded plug 24. A valve 25 comprises a valve body 26 located in a recess 27 formed in the upper surface 11 of the housing 12. The valve body 26 defines a valve chamber 28 communicating with an inlet port 29 extending upwardly into communication with the lowermost portion 10 of the tank chamber 3. A horizontally extending side port 30 communicates between the valve chamber 28 and the transfer duct 23 and a downwardly extending outlet port 31 communicates between the valve chamber 28 and an outlet duct 32 bored in the block 13.

A ball-like valve member 33 is located in the valve chamber 28 and is supported on a vertical valve stem 34 which extends into the valve chamber through the inlet port 29. The valve stem 34 is connected to a valve actuator 35 arranged to reciprocate the valve stem between a first position in which the valve member 33 is lowered so as to close the outlet port 31 and a second position in which the valve member is raised to close the inlet port 29.

The outlet duct 32 is connected to a discharge nozzle 36 by means of a discharge channel 37 formed in a horizontally projecting nozzle block 38 which is mounted on the base 15.

A thermally insulating enclosure 39 surrounds both the tank 2 and the housing 12 and the nozzle block 38 projects through the enclosure at the same level as the base 15 i.e. at the lower end of the housing 12. The enclosure is spaced from the tank 2 and th housing 12 such that they are separated from the enclosure by an air gap 43.

The housing 12 is heated by means of a cylindrical electrical band heater 40 mounted in

external circumferential contact with the block 13 and an electrical cartridge heater 41 which is received within a horizontal channel 42 in the base 15.

A further electrical pad heater 44 is mounted externally on the nozzle block 38.

A return pipe 45 also projects through the enclosure 39 and communicates with the tank chamber 3 via a vertical return bore 46 extending through the block 13 and base 15 and a horizontal bore 47 formed in the base 15. The return pipe 45 is coupled to one end of the horizontal bore 47 which is closed at its other end by a blanking plate 48.

In use molten metal is heated in the tank 2 by means of the band heater 7 and the housing 12 together with the nozzle block 38 is heated by means of the band heater 40, pad heater 44 and the cartridge heater 41 such that the tank, housing and nozzle block are maintained at a uniform temperature. During start-up, the sequence of heating is to first turn on the uppermost band heater 7, secondly the middle band heater 40 and then the lowermost cartridge heater 41. This sequence takes account of the expansion of alloy on melting and avoids build up of excessive pressure which could burst the housing 12. The thermally insulating enclosure 39 assists in retaining heat and maintaining uniformity of temperature by limiting heat losses and providing a trapped volume of heated air in the air gap 43 which contributes to the even distribution of heat by convection. During normal use molten metal is delivered to a die (not shown) connected to the discharge nozzl 36 during a downward dispensing stroke of the piston 18 whilst the valve 25 is operated with the valve member 33 in its second position (raised so as to close the inlet

port 29). Molten metal displaced from the dispensing chamber 19 flows through the channel 22, the transfer duct 23, the inlet port 30, the valve chamber 28, outlet duct 32 and discharge channel 37 to be delivered through the nozzle 36.

On completion of the dispensing stroke the valve actuator 35 lowers the valve member 33 into its first position in which the outlet port 31 is closed. Raising of the piston 18 by the piston actuator 21 expands the dispensing chamber 19 to draw molten metal from the tank chamber 3 via the valve 25.

During each dispensing stroke the level 5 in the tank chamber will fall corresponding to the volume of molten metal dispensed since molten metal will flow into the bore 16 above the piston 18. The apparatus can continue to dispense molten metal from the tank 2 so long as the level 5 covers the inlet port 29. It is important that the alloy level 5 does not fall sufficiently low to allow any surface skin or residue to be sucked into the valve 25. A level probe (not shown) is provided in the chamber 3 to detect whether the level has reached a minimum level and an automatic cut-out then prevents further operation. Dispensing can therefore continue until the level 5 reaches almost the lowermost portion 10 of the tank chamber 3 thereby consuming almost the entire volume of molten metal.

The dispensed molten metal is used to form castings which are then used as core elements of moulds for engineering plastics. After use the core elements are melted down and molten alloy is returned to the tank chamber 3 via the return pipe 45 so that the tank chamber is refilled through return bore 46.

An alternative embodiment is shown in Figure 2 where corresponding reference numerals to those of

Figure 1 are used where appropriate for corresponding elements. The alternative apparatus 50 of Figure 2 has a discharge nozzle 36 mounted on a nozzle block 38 which is connected to the tank 2 and is therefore at a higher level than the nozzle 36 of the apparatus 1.

The nozzle block 38 of Figure 2 is connected by a pipe 51 to the base 15 so as to communicate with the outlet duct 32. The pipe 51 is heated by means of a trace heater 52.

A further alternative casting apparatus 55 is shown in Figure 3 where corresponding reference numerals to those of previous Figures are used where appropriate for corresponding elements. Apparatus 55 has a discharge nozzle 36 mounted on a nozzle block 38 connected to the base 15 by a flexible hose 56 so as to communicate with the outlet duct 32. The hose 56 is heated by a tubular heating device 57.

A further alternative casting apparatus 60 is shown in Figure 4 where corresponding reference numerals to those of preceding Figures are used where appropriate for corresponding elements.

Apparatus 60 is a modified version of the casting apparatus 1 in which the valve 25 can be removed for servicing and can then be replaced without the need to drain alloy 4 from the tank chamber 3.

The valve 25 of apparatus 60 has a modified body 70 which includes a tubular extension 71 projecting upwardly through the chamber 3 such that an upper end 72 of the extension is located above the maximum level of alloy in the chamber.

Th valve body 70 is received as a sliding fit within cylindrical recess 27 of the housing 12. An annular groove 73 in the valve body 70 receives a metallic annular seal 74 at a level which is above

the side port 30. The seal 74 makes sealing contact with the walls of the recess 27 and acts to prevent leakage of alloy between the external surface of the valve body 70 and the side walls of the recess 27.

A bracket 75 is connected to the wall 6 of the tank and projects horizontally over the tank chamber 3 at a level which is spaced above the upper end 72 of the extension 71. Three screws 76 are received in threaded bores in the bracket 75 and project downwardly into contact with the upper end 72, the screws 76 having pointed lower ends and being circumferentially equi-spaced such that by adjusting the screws into firm contact with the upper end 72 any tendency for the valve body 70 to rise in response to pressure within the valve chamber 28 is resisted.

Radial ports 77 are provided in the tubular extension 71 at a level just above the upper surface 11 of the housing 12 to admit alloy 4 into the tubular extension 71 so as to communicate with the inlet port 29 of the valve 25.

The valve body 70 is provided with a further annular groove 78 receiving a seal 79 at a level below the side port 30.

The valve body 70 has a lower end 80 having a detachable end plate 81 which defines a valve seat against which the valve member 33 makes sealing contact when the valve member is lowered to its fullest extent. The end plate 81 is detachable to allow ease of access to the valve chamber 28 to service the valve member 33.

To remove the valve body 70 the bracket 75 is detached from the tank 2 and removed. The valve body 70 can then be lifted vertically from the recess 27 by gripping upper end 72 of the extension 71. During this travel the valve body 70 acts as a piston within

recess 27 so that it is necessary to allow the pressure of alloy within the valve chamber 28 to equalise with the pressure of alloy within the tank chamber 3 for example by freeing the piston 18 to move vertically in response to fluid pressure.

Replacement of the valve body 70 follows a reverse procedure with the screws 76 being adjusted if necessary.

A further alternative apparatus 85 is shown in Figure 5 where corresponding reference numerals to those appearing in previous figures are used where appropriate for corresponding elements.

The apparatus 85 includes a hood 86 which extends over the tank 2 so as to form an airtight enclosure 87 above the alloy level 5. The valve stem 34 and the piston rod 20 project through sealed apertures 88 and 89 respectively in the hood 86 and the enclosure 87 is pressurised using nitrogen supplied via a pipe 90 from a gas cylinder 91. A visual gas pressure indicator 92 is provided in the pipe 90.

In use the enclosure 87 is pressurised at a pressure of between 1 and 2 inches water gauge in order to exclude air from the enclosure.

Greater pressures of inert gas may also be applied in order to apply pressure to the alloy to assist in clearing blockages which might for example occur in the return pipe 45.

A further alternative apparatus 95 is shown in Figure 6 where corresponding reference numerals to those of previous figures are used where appropriate for corresponding elements.

Figure 6 is a s ctional view showing detail of the return pipe 45 and return bore 46 being connected via an enlarged pre-heating chamber 96 which is formed within the base 15. Detailed features of the

apparatus 95 are removed from Figure 6 for clarity.

A thermocouple 97 is provided in the base 15 adjacent to the pre-heating chamber 96 and the block 15 is heated by cartridge heaters 98 and 99. The temperature of the block 15 is monitored by means of the thermocouple 97 and the heating of the cartridge heaters 98 and 99 is regulated accordingly in order to maintain the contents of the pre-heating chamber 96 in a molten state.

The band heaters 7, 40 and 44 are mica bands in which labyrinth electrical conductors are impregnated and these are connected to an AC supply to provide resistive heating. In each case the band heater is formed of two semi-cylindrical shells which are separable to facilitate removal and replacement.

The tank 2 may alternatively be formed unitarily with the block 13 as a single casting.

The above apparatus may also be used for dispensing alloy to be used in the encapsulation of workpieces.

CLAIMS:-

1. Casting apparatus comprising a tank defining a tank chamber receiving molten metal in use, a housing defining a bore, a piston slidably received in the bore to define in the bore a dispensing chamber of variable volume, valve means selectively operable in a first position to connect the dispensing chamber to the tank chamber and in a second position to connect the dispensing chamber to a discharge nozzle, the housing being connected to the tank such that in use the housing projects downwardly from and externally of the tank and such that the bore has an upper end communicating with the lowermost portion of the tank chamber, and further comprising heating means operable to heat the housing.

2. Casting apparatus as claimed in claim 1 wherein the valve means comprises a valve body formed integrally with the housing such that the valve means is heated in use by action of the heating means.

3. Casting apparatus as claimed in any preceding claim wherein the valve body comprises an inlet port communicating with the lowermost portion of the tank chamber.

4. Casting apparatus as claimed in any of claims 2 and 3 wherein the valve body is removably connected to the housing and includes an extension which projects in use from the body through the tank chamber to a level which is above the level of molten metal so as to be accessible for removal of the valve body from the housing.

5. Casting apparatus as claimed in claim 4

wherein the body is slidably received in a recess defined in the housing, the valve means comprising seal means disposed between the body and the housing.

6. Casting apparatus as claimed in any preceding claim wherein the heating means comprises an electrically heated jacket operable to heat an external surface of the housing.

7. Casting apparatus as claimed in any preceding claim wherein the heating means comprises an electrically heated cartridge located in a channel defined by a lower portion of the housing.

8. Casting apparatus as claimed in any preceding claim wherein the tank chamber has a bottom surface constituted by a top surface of the housing.

9. Casting apparatus as claimed in any preceding claim wherein the tank is provided with a hood defining an enclosure covering the tank chamber and means operable to introduce inert gas into the enclosure.

10. Casting apparatus substantially as hereinbefore described with reference to and as shown in any of the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number 9110655.

Relevant Technical fields

(i) UK Cl (Edition K) B3F (FJA:FKB)

(ii) Int Cl (Edition 5) B22D

Search Examiner

A.B.W. FLOWERDAY

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

22 July 1991

Documents considered relevant following a search in respect of claims 1-9

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
	NONE	

SF2(p)

MSAAK

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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